Improved X-Ray Filters with Al-Sc Alloys and Nanoparticle-Doped Polyimide, Phase I

Completed Technology Project (2018 - 2019)

Project Introduction

The next generation of detectors for high energy observatories needs a significant improvement in filter technology, as identified in the SBIR solicitation and as a PCOS technology gap. We propose a two-fold change in the state of the art of thin film EUV and x-ray filters, using Al-Sc alloy in place of Al and adding Au nanoparticles to polyimide. Al-Sc alloys show smaller grain sizes that should translate to increased strength and decreased optical/IR transmission, even for alloying fractions <1% that would not noticeably impact the x-ray spectrum. Surface plasmon resonances (SPR) in Au nanoparticles allow tunable absorption peaks for optical thermal control and baking. Since SPRs effectively enlarge the absorption cross section of nanoparticles, we expect to achieve a narrowband visible optical depth of ~0.2 with an x-ray transmittance of >95% (nanoparticles only). We lay out a fabrication and testing plan to push these technologies from TRL2 to TRL4 by the end of Phase I by demonstrating heating of doped films, optical and infrared density of alloyed films, and beamline measurements of x-ray transmittance and density of constituent species in integrated Al-Sc/doped polyimide filters.

Anticipated Benefits

This work targets the requirements of large-format thin film filters for high-energy observatories. Increased strength and optical density for metal layers and non-contact thermal control will improve the state of the art of optical and infrared blocking filters and contamination blocking filters. Increased strength of Al via alloying also improves its usefulness as a window in low-pressure differential laboratory gas cell experiments to characterize aerosols and model planetary atmospheres.

Increased optical/IR density and thermal stability afforded by alloying Al is directly applicable to IR-pumped high harmonic generation laser experiments, free electron lasers, synchrotrons, and x-ray instrumentation and metrology tools where pure Al is the current standard. Inertial confinement fusion experiments have a need for resonant absorption of doped polyimide, where pre-heating lasers can remove polyimide layers in the microseconds prior to a shot.

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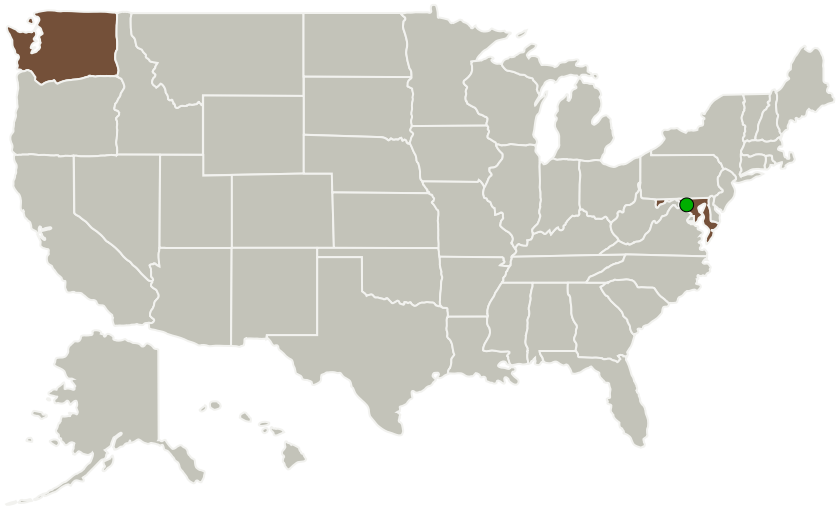
Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
Luxel Corporation	Lead Organization	Industry Small Disadvantaged Business (SDB)	Friday Harbor, Washington
Goddard Space Flight Center(GSFC)	Supporting Organization	NASA Center	Greenbelt, Maryland

Primary U.S. Work Locations	
Maryland	Washington

Project Transitions

July 2018: Project Start

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Organization:

Luxel Corporation

Responsible Program:

Small Business Innovation Research/Small Business Tech Transfer

Project Management

Program Director:

Jason L Kessler

Program Manager:

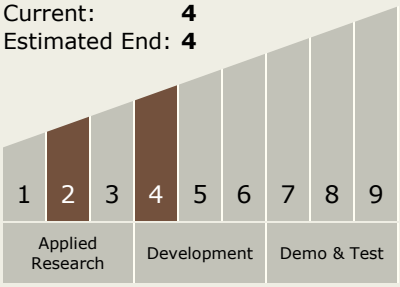
Carlos Torrez

Principal Investigator:

Benjamin Zeiger

Technology Maturity (TRL)

Start: **2**
Current: **4**
Estimated End: **4**



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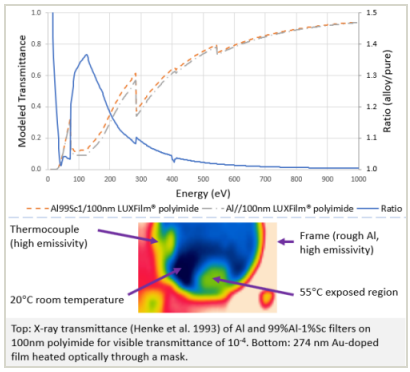
February 2019: Closed out

Closeout Documentation:

- Final Summary Chart*(https://techport.nasa.gov/file/141106)*

Images

Briefing Chart Image
Improved X-Ray Filters with Al-Sc Alloys and Nanoparticle-Doped Polyimide, Phase I
(https://techport.nasa.gov/image/136362)



Final Summary Chart Image
Improved X-Ray Filters with Al-Sc Alloys and Nanoparticle-Doped Polyimide, Phase I
(https://techport.nasa.gov/image/132020)

Technology Areas

Primary:

- TX08 Sensors and Instruments
  - TX08.1 Remote Sensing Instruments/Sensors
    - TX08.1.3 Optical Components

Target Destinations

Outside the Solar System, Others Inside the Solar System